3.3 Koralen

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5.1 Coral seas

Clear, blue waters surround the world's 284 300 km^2 of coral reef ecosystems. Reef structures are, arguably, one of the greatest intersections between the physical structure of an environment and the organisms that live there. Just as in tropical rainforests, in coral reef communities the living organisms in the environment actually provide the structure necessary for the many microhabitats of the community to exist. These microhabitats provide homes to thousands of marine species. The species surviving on a coral reef, as well as the coral itself, create one of the most beautiful and biodiverse communities on our planet: a community that is reliant on the physiology of the coral animal for health and survival.

One of the most well-known coral reef systems is the Great Barrier Reef off the coast of Queensland, Australia. This reef system is home to over 2900 individual coral reefs housing more than 2000 species of animals, from corals to whales.

Unfortunately, this beautifully biodiverse community, like other coral reefs worldwide, is under attack.

Climate change, pollution and reef erosion are happening at rates that are dangerous for the world's coral reefs. Over 90% of the corals living on the Great Barrier Reef are suffering from a disease called **coral bleaching**. More than 20% of those corals affected have already died because of the loss of nutrients caused by the bleaching. Coral bleaching tends to happen in areas with rising water temperatures and increased levels of pollution. Recovering from the disease is possible but not easy. It is vital that we begin the process of cleaning up our oceans and reducing our ecological impact in order to give the coral communities their best chance at survival.

KEY TERM

Coral bleaching: the loss of symbiotic algae from the tissues of corals as a result of environmental factors

5.2 Coral physiology

All corals belong to a special phylum of organisms called cnidarians. Animals in this phylum are found in aquatic ecosystems, primarily marine, and all capture food using stinging cells called cnidocytes. The presence of these stinging cells in coral polyps indicates a close relationship with sea anemones and jellyfish.

Like anemones, corals live their entire adult life as polyps. Polyps are the sessile (non-moving) life stage of coral animals. Polyps tend to be simple in appearance, just a cylinder of epidermal tissue with tentacles surrounding a mouth. This mouth leads to a simple, sac-like stomach, or gastrovascular cavity, made of tissue designed to secrete enzymes for digestion. Polyps may live individually or in giant colonies capable of building reefs. There are two major categories of corals: those that build reefs, **hermatypic** corals, and those that do not build reefs, **ahermatypic** corals.

KEY TERMS

Ahermatypic: soft corals that do not build reefs

Hermatypic: hard corals capable of reef-building

Zooxanthellae: symbiotic, photosynthetic dinoflagellates living within the tissues of many invertebrates

Ahermatypic corals are routinely referred to as soft corals because they are flexible and do not create stony skeletons, using proteins for support instead. Soft corals resemble plants, trees or fans, and generally do not maintain a symbiotic relationship with **zooxanthellae**, photosynthetic dinoflagellates that can be found in the tissues of corals and many other marine invertebrates. Some examples of soft corals are sea whips, sea fans and gorgonians.

Hermatypic corals, or hard corals, are the reef-building group of corals. Within this group, the coral polyps always live in colonies and always include zooxanthellae (Figure 5.1). These colonies begin when a single planktonic coral larvae settles on a hard substrate. Once the larvae has attached, it goes through metamorphosis to become a coral polyp. If this original polyp survives and thrives, it will reproduce asexually through a process called budding. Budding happens when the initial polyp grows a clone of itself. As a result of this process, typically all polyps in a coral colony are genetically identical to the founder polyp. In order to cement themselves to the substrate, each polyp secretes calcium carbonate ($CaCO_3$) onto the substrate. When an older polyp dies, a new polyp will grow in its place, adding another layer of calcium carbonate to the structure. Eventually, this process creates a limestone skeleton that can form many different shapes and provides the framework of the coral reef. Because coral polyps are so tiny, it can take billions of polyps to form a reef.

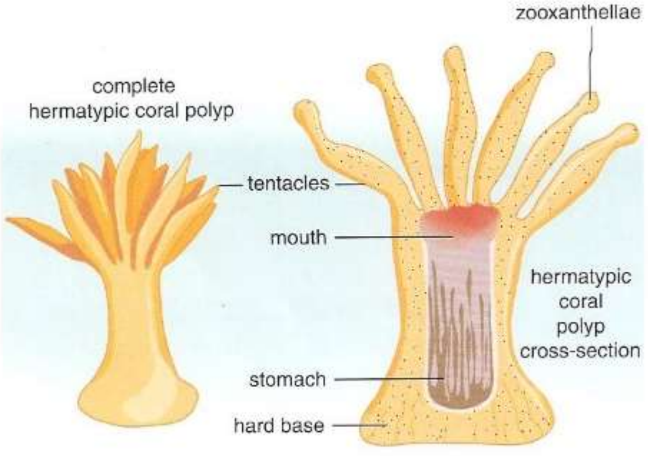

Figure 5.1. Hermatypic coral polyp with symbiotic zooxanthellae.

It is important to note that hermatypic corals would probably be unable to build reefs without the symbiotic relationship they maintain with zooxanthellae. Zooxanthellae are microscopic, single-celled dinoflagellates that live within the tissue of hard corals (Figure 5.1). Using the carbon provided by the coral host, zooxanthellae perform photosynthesis to generate organic material that can then be passed on to the coral. Without the extra nutrition provided by zooxanthellae, corals would be unable to secrete enough calcium carbonate to build the skeleton of the reef. The zooxanthellae provide enough food for the coral in clear, sunny waters so that often the coral can survive without eating. Coral are predators, however, even if zooxanthellae support them. Coral polyps use their tentacles filled with cnidocytes to prey on microscopic zooplankton floating in the water near them.

5.3 Physical factors necessary for coral growth

In 1842 Charles Darwin published a book called *Coral Reefs* based on his observations aboard the HMS *Beagle* between November 1835 and April 1836. This book would become central to the discussion of how coral reefs form and the environment necessary for their unimpeded growth. In the book, Darwin included a map of all the known coral reefs. This map showed where in the world coral reefs are most likely to be found: between 30° north and 30° south of the equator. It is interesting to note that, despite a lack of modern equipment, Darwin's map, and the observations that formed it, are still largely accurate today. Darwin also distinguished between three major types of reef (fringing, barrier and atoll) and how each is formed, which you will find out about in the following section.

Coral reefs are reliant on several physical factors for healthy growth and colonisation, particularly an appropriate temperature, water clarity and suitable depth. When mapping out coral reef distribution (Figure 5.2), scientists can hypothesise which reefs will have the highest growth rates by evaluating the presence, or lack, of these vital physical factors. As the combination of these factors is prevalent within an area referred to as the 'tropics', this is where coral reefs are most likely to be found.

The most important physical factor for corals is temperature. Hard corals are limited to waters with temperatures ranging between 16 °C and 35 °C (61–95 °F). Corals growing in water with temperatures at either end of this range tend to be less healthy and grow less quickly than those in water of the preferred range of 23–25 °C (73–77 °F). Because of the warm temperatures needed for successful coral growth, you would expect to find coral reefs located exclusively in the tropics between 30 °N and 30 °S of the equator. However, some areas outside this zone, such as Florida and southern Japan, are also able to support healthy coral reefs. This is because there are warm water currents flowing along the continental shelf in those areas.

A suitable depth of water is needed for healthy coral growth. While all corals grow in the subtidal zone, those present in areas within 20 m of the surface tend to have the fastest growth rate. Because of the symbiotic nature of coral's relationship with photosynthetic zooxanthellae, you do not find coral reefs in deeper water because there is insufficient light. Those corals that do not use zooxanthellae may be found in deeper waters with warm enough temperatures.

In order for zooxanthellae to photosynthesise efficiently, sunlight must be able to reach the coral polyps at sufficient levels. Therefore, water clarity is also vital to the health and growth of coral reefs. If the light is unable to reach the coral polyps, the zooxanthellae cannot produce the organic material necessary for the coral to build up the reef. This reduces overall growth and potentially stresses the coral, which is why clear water without silt or an excess of nutrients is needed for rapid coral growth. An abundance of nutrients may lead to an algal bloom that can cloud the surrounding water and reduce light penetration. An excess of small sediments, like silt, also causes turbidity, or cloudiness, within the water.

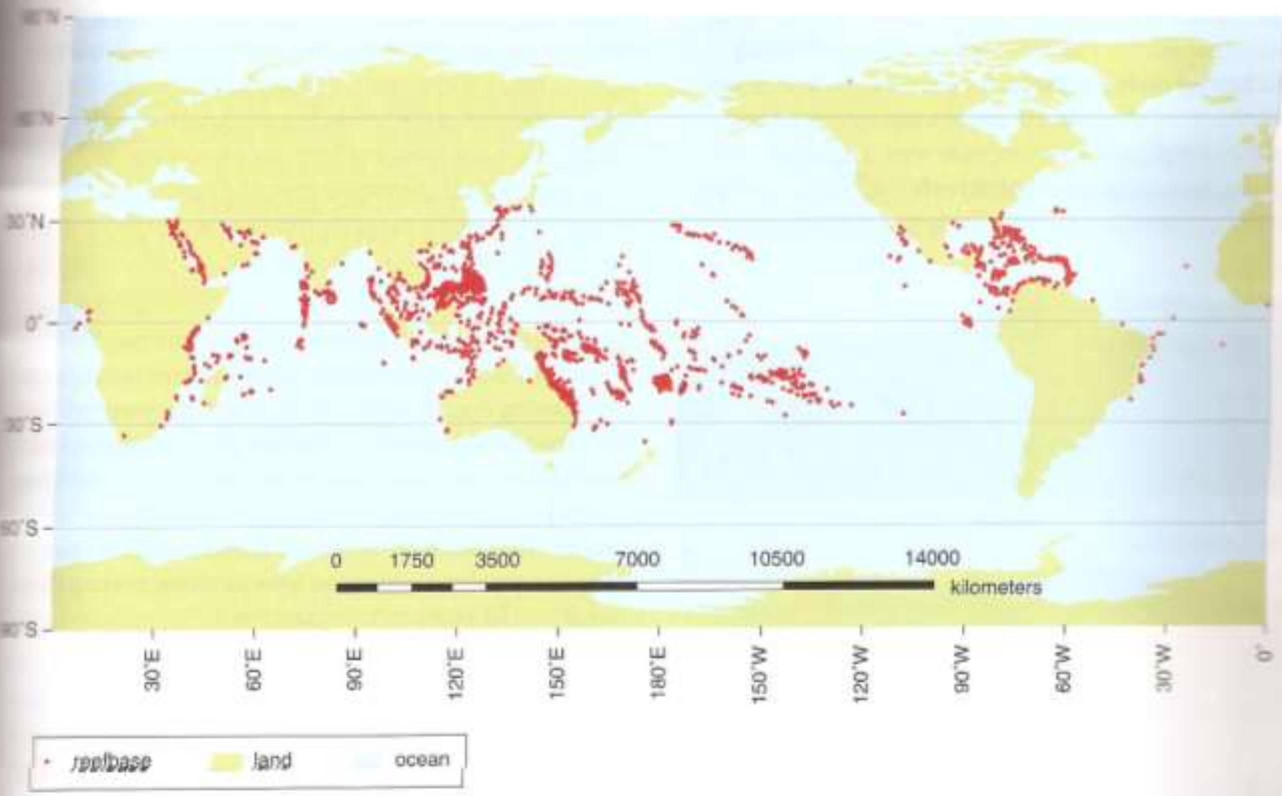

Figure 5.2. A map of the world's coral reefs.

Salinity and substrate are determining factors in the success of a coral reef. Corals must have an appropriate rocky surface for attachment. Coral larvae cannot attach to sand or other unstable materials, so the larvae tend to attach to denser materials. The basaltic rocks of undersea mountains and other hard surfaces along the continental shelf provide excellent attachment sites for the larvae. Corals are not adapted to freshwater or brackish conditions. For this reason, they do not do well near river mouths or other areas linked with fresh water or run-off flowing into the sea.

A final physical factor determining coral health is pH. Scientists use pH to determine how acidic or basic a substance is on a logarithmic scale of 0–14. Acidic substances have a pH below 7; neutral substances have a pH around 7; basic substances have a pH above 7. For healthy growth in coral reefs to occur, the ocean should be slightly basic, with a pH between 8.1 and 8.5. Waters with lower pH levels stress the corals and cause bleaching.

If a coral larva has found a location that meets all of these requirements, it will thrive and begin the process of reef-forming. Coral polyps will continue to add to existing coral skeletons, growing outwards for thousands of years. If the seabed subsides, or sinks, the coral polyps will tend to grow vertically to maintain the appropriate depth for photosynthesis. This will also occur if there is sea-level rise, as when polar ice caps melt adding water to the ocean.

SELF-ASSESSMENT QUESTIONS

1 Explain why coral reefs are most commonly found within 30 °N and 30 °S of the equator.

2 Suggest which physical factors are linked most closely with the symbiotic relationship coral has with zooxanthellae. Support your answer with evidence.

5.4 Types of reef

Geomorphology is a term used to describe the scientific study of landforms and the processes involved in creating those landforms. While aboard the HMS *Beagle*, Charles

KEY TERM

Geomorphology: the study of the characteristics, origin and development of landforms

Darwin studied the geomorphology of coral reefs. In doing so, Darwin observed three fairly distinct types of reef: **fringing reefs**, **barrier reefs** and **atolls**. In his book *Coral Reefs*, Darwin writes about the differences between these three reefs and how they are all connected. Since Darwin's time, a fourth reef type has been categorised: **patch reefs** (Figure 5.3). However, whether or not this is a true fourth category is debated.

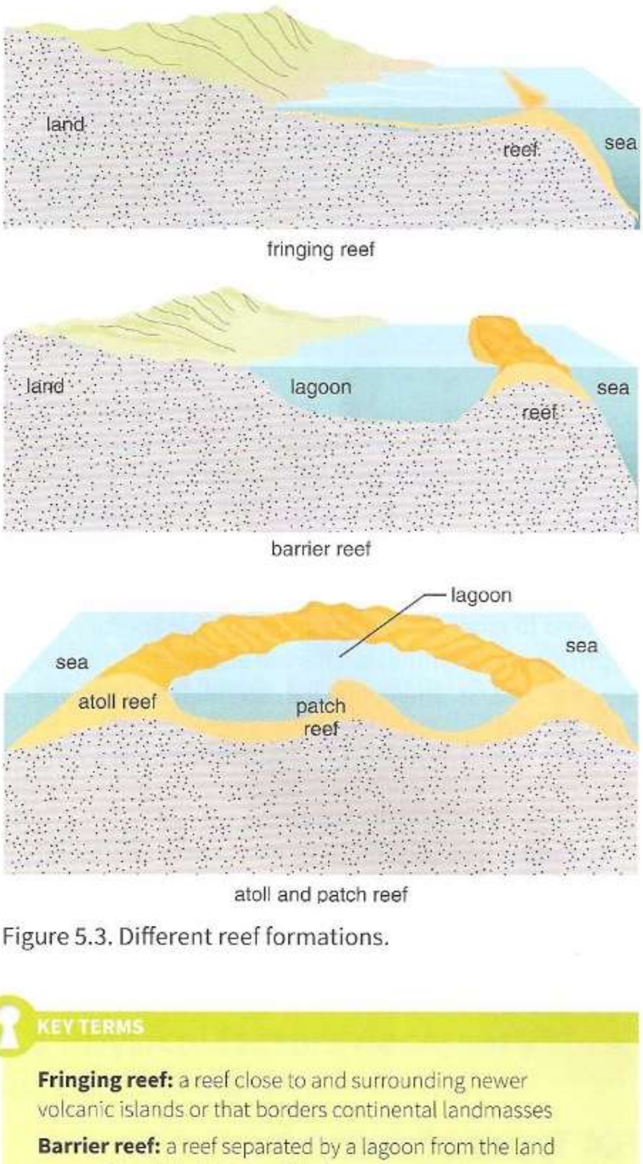

Figure 5.3. Different reef formations.

KEY TERMS

Fringing reef: a reef close to and surrounding newer volcanic islands or that borders continental landmasses

Barrier reef: a reef separated by a lagoon from the land mass with which it is associated

Atoll: a coral reef somewhat circular in shape with a central lagoon

Patch reef: small, isolated reef usually located within the lagoon of a barrier reef

Darwin hypothesised that all reefs begin as fringing reefs. Fringing reefs form along the edges of continental landmasses, islands and oceanic volcanoes. Fringing reefs are separated from the shoreline by narrow, shallow lagoons. Rocky shorelines are the best substrate for the initial placement of the larvae, but a soft bottom will do as long as there is at least one hard place to cement to. Fringing reefs are the most commonly seen and explored because they tend to be easy to reach. This nearness to shore makes them vulnerable to excessive sediment, run-off containing pollutants and fresh water, and human disturbance.

Barrier reefs are similar to fringing reefs in that they lie along the shoreline of a larger landmass. Barrier reefs are separated from land by deeper, wider lagoons and may be up to 97 km from the shore. A lagoon is a shallow, sheltered body of water that typically has a soft sediment bottom. Fringing reefs may even exist within the lagoon created between the barrier reef and the shoreline. Portions of barrier reefs may have grown so that the water above is very shallow, making them dangerous for boats to travel over them.

Typically found between fringing reefs and barrier reefs are patch reefs. Patch reefs are the smallest of the reef types and they tend to grow vertically from the continental shelf or lagoon floor as an isolated formation within the lagoons formed by barrier reefs. The size of patch reefs can vary based on age and location, but they rarely have the vertical height needed to reach the water's surface. It has been argued that patch reefs are actually just a formation within a barrier reef and should not be placed in a separate category.

The final category of reefs are atolls. An atoll is a coral reef that develops as a ring around a central lagoon. Atolls vary in size from 1 to 32 km in diameter. Most atolls can be found in the tropical Indian Ocean and the west and central Pacific Ocean; they are rare in Caribbean and Atlantic oceans. Atolls vary drastically from fringing and barrier reefs in their location. Typically, atolls are found kilometres from any visible land in incredibly deep water. This enormous distance provided a challenge to the scientists of Darwin's day. These scientists, including Darwin, wanted to be the first to determine how atolls formed.

Darwin–Dana–Daly theory of atoll formation

After much observation and consideration on his HMS *Beagle* voyage, Darwin was certain he had worked out how atolls were formed. According to Darwin, the type of reef seen was dependent on time. He described a fringing reef as the first, which would lead to a barrier reef and subsequently end up as an atoll. After Darwin released his hypothesis of atoll formation, It was supported and modified by two leading geologists of the day: James Daly and Reginald Dana.

The Darwin–Dana–Daly theory of atoll formation can be summarised as follows. Coral larvae begin to colonise the basaltic rocks along the coastline of a recently emerged oceanic volcano (sea mount). The corals continue to grow and colonise, creating a fringing reef around this island. The island then begins to erode at the top and sinks slowly beneath the sea. (It has since been discovered that tectonic activity is responsible for this sinking.) As the island sinks and erodes, a lagoon begins to form and grow between the reef and the island. Once the lagoon has grown sufficiently, the reef is classified as a barrier reef. This reef continues to grow around the area where the island had been, despite the continuous sinking of the island. Eventually, the island sinks entirely below the surface of the water, leaving behind a ring of coral, an atoll, with a relatively shallow lagoon in the centre (Figure 5.4).

This theory has since been supported by data from multiple sources. As an example, when scientists took drilling cores of the Bikini Atoll in the Pacific Ocean, the data showed that coral age increased with depth. Those corals located at the base of the atoll, nearly 1200 m deep, were 50 million-year-old fossilised coral species, while those at the surface were living modern species. After testing the substrate under the fossilised corals, scientists found volcanic rock, supporting the idea that the original corals settled along the edges of a recently emerged volcanic island. As these fossil corals, now located more than 1000 m below the surface, could only have grown in shallow waters, this provides even more evidence supporting the idea that the island sank over time.

SELF-ASSESSMENT QUESTIONS

3 Compare and contrast the three major types of reefs: fringing reefs, barrier reefs and atolls, paying particular attention to formation and age.

4 Summarise the evidence used to support the Darwin–Dana–Daly theory of atoll formation.

5.5 Reef erosion

A healthy coral reef in a location where all physical factors are being met can expect to accumulate between 3 and 15 m of calcium carbonate every 1000 years. The largest of the coral species are the slowest growing, often only adding between 5 and 25 mm of calcium carbonate a year. The faster growing corals, such as staghorn corals, can add as much as 20 cm to their branches per year. According to current geological estimates, most modern coral reef systems are between 5000 and 10 000 years old. This slow growth rate of healthy corals is one reason why **reef erosion** can be so detrimental.

When a coral reef begins to lose more calcium carbonate each year than it accumulates, it is undergoing reef erosion. There are many causes of reef erosion, both biological and

KEY TERM

Reef erosion: the gradual wearing away of a coral reef by the action of living organisms (bioerosion) and physical factors, such as storms

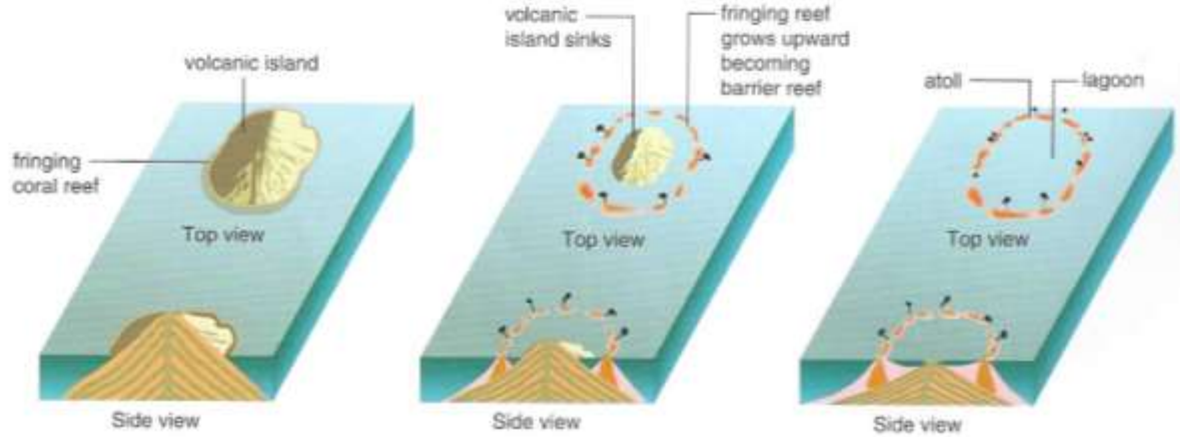

Figure 5.4. An aerial and side view of atoll formation.

physical. Biological causes of reef erosion, often referred to as bioerosion, include the predation of coral by organisms such as the parrotfish, butterflyfish and the crown-of-thorns starfish. Physical causes of reef erosion include storms, exposure to air and ocean acidification.

Both parrotfish and butterfly fish are avid predators of coral polyps among coral reefs. Butterfly fish tend to be specialists, eating only a few particular species of polyps. Parrotfish, on the other hand, are grazers that eat coral polyps in order to get to the algae living within them. Parrotfish will use their beak-like teeth to bite off portions of rock or coral reef, which they swallow whole. Their bodies then digest all of the organic material (i.e. the algae) located within the coral polyps and release the indigestible calcium carbonate as faeces. This process leads to an overall loss of calcium carbonate present on the reef, causing reef erosion.

The crown-of-thorns starfish (*Acanthaster planci*) has been a serious threat to corals in the Indo-Pacific region for the last 50 years. These coral predators have seen multiple population booms and are considered to be the greatest cause of coral mortality on the Great Barrier Reef. There are several hypotheses about what causes an outbreak of crown-of-thorns starfish, but the most likely is nutrient-rich run-off as a result of the overuse of fertilisers combined with the removal of predators. These nutrients, primarily nitrogen and phosphorus, tend to cause plankton blooms where crown-of-thorns starfish larvae thrive. Without predatory fish to control the population of larvae, the larvae metamorphose into adult starfish and devour the reef.

Physical damage to reefs during low tide can also be extensive. Because corals need to be in subtidal regions, any exposure to air can be dangerous. During spring tides, the lowest of the tides can leave coral reefs exposed to the air, causing the corals to desiccate or overheat. When the coral polyps die, they may be replaced with algae or slowly eroded.

Storms are another major source of reef erosion. The turbulence caused by hurricanes, typhoons and tropical storms can be extensive. Typically, the damage is caused by breakage of the coral itself or a scouring of the coral by abrasive sediments that are being swirled through the normally calm waters. Evidence of the damage to the Great Barrier Reef caused during cyclone Ita is shown in Figure 5.5.

Corals can generally recover from hurricane damage but the time the recovery takes is influenced by several factors, including:

- the amount of coral rubble remaining after the storm
- the sediment stirred up by turbulence
- the growth of algae competing for attachment surfaces within the reef
- run-off, which may bring toxins, lower the salinity of the water and increase nutrients, encouraging an algal bloom.

For example, Hurricane Hattie destroyed a 43 km stretch of barrier reef off the coast of British Honduras in 1961. At the time it was estimated that 80% of the Belize Barrier Reef was damaged by this storm. While the reef has since recovered, scientists at the time believed it would take between 25 and 100 years for the ecosystem to repair itself.

Over the last 300 million years the pH of the world's oceans has been slightly basic, at an average pH of 8.2. However, within the last 200 years, since the Industrial Revolution, it has dropped to 8.1. This drop seems tiny, but the pH scale is logarithmic, so a 0.1 drop represents a 25% increase in acidity. This process is called **ocean acidification**. The gases in our atmosphere (especially carbon dioxide) dissolve at the ocean surface (see Chapter 7). This creates higher levels of carbonic acid (H_2CO_3), lowering the overall pH of the

Figure 5.5. A portion of the Great Barrier Reef before and after the category five tropical cyclone Ita passed through in 2014.

ocean. This acidity is having an abnormally large impact on coral reefs that use calcium carbonate in the manufacture of their skeletons. Ocean acidification prevents corals from absorbing all of the calcium carbonate they need to build their skeletal structures. This can lead to the skeletons themselves dissolving in the more acidic water.

KEY TERM

Ocean acidification: a reduction in the pH of the ocean over an extended period time, caused primarily by uptake of carbon dioxide from the atmosphere

Coral bleaching and climate change

The term **climate change** refers to changes in global or regional climate patterns and more specifically to the changes that have been seen since the late 20th century. Many studies have found a correlation between the rate of climate change and rising levels of carbon dioxide in our atmosphere as a result of fossil fuel use. Climate change has two primary impacts on ocean ecosystems: a rise in sea surface temperatures and a lowering of pH levels.

KEY TERM

Climate change: changes in global or regional climate patterns, especially changes that have been seen since the late 20th century

Coral bleaching occurs when hard corals become stressed by environmental factors, particularly rising water temperature and acidity. This stress causes the coral polyps to reject their symbiotic zooxanthellae. Because the zooxanthellae contain all the pigments that give the coral polyps their colour, the bright white calcium carbonate skeleton of the reef becomes visible (Figure 5.7). This change from yellows and browns to white is called bleaching. While bleached, corals are not adding to their calcium carbonate skeletons, so reef growth stops. If the bleaching event lasts too long the corals will die as a result of lack of nutrients and poor conditions. There have been multiple mass bleaching events around the world since the mid-1990s.

Figure 5.7. A healthy coral and a bleached coral in the Florida Keys.

Impacts of reef erosion and artificial reefs

While many people see coral reefs as beneficial only in terms of biodiversity in the ocean, they are also of benefit to onshore habitats. Coral reefs absorb on average 97% of the energy of waves coming into shore. Wave height is also reduced, on average by 84%. These reductions in wave energy and height have important implications for the shoreline. By reducing the oncoming wave energy, coral reefs are able to protect the shoreline from erosion caused by strong waves. Preventing erosion of the shoreline and reducing wave height helps to protect anything on the shore from being damaged during storms and being lost to the sea as a result of erosion. Those ecosystems that exist along the shoreline, for example mangroves, also benefit from reduced wave action and serve as nurseries for marine organisms.

Healthy coral reefs also help protect boats and **anchorages**. Many coastal communities provide breakwaters to create anchorages, areas where people anchor their boats. These breakwaters can be expensive. However, where there is a healthy coral reef, the reduced wave action means there is less need for a breakwater, reducing the cost to the community. Additionally, the anchorage itself is safer for boats because the coral reduces turbulence in the area, calming the waters. The reduction in erosion and cost of breakwaters means areas with healthy coral reefs have a significant economic advantage over those areas without.

Those areas with coral reefs suffering from reef erosion are therefore at an economic disadvantage. Coastal properties and shores are at a greater risk of exposure to the damaging effects of waves, particularly during tropical cyclones. The loss of shoreline and greater damage by storm surges can cost human communities millions of dollars to repair. This is why many communities are creating **artificial reefs**. In addition to increasing biodiversity and ecological stability, artificial reefs provide many of the other benefits of healthy coral reefs. Artificial reefs help reduce wave energy and height, behaving as a submerged breakwater. This protects anchorages and boats from damage, and shorelines from erosion.

Artificial reefs are human-made structures designed to recreate a coral ecosystem. Typically these reefs are placed in areas that do not have an appropriate substrate for larval attachment. Many different materials have been used to create artificial reefs, including specially designed non-toxic concrete, sacks filled with sand, stone blocks and even sunken ships. Figure 5.8 illustrates one type of artificial reef: the reef ball. The USS *Oriskany*, a retired aircraft carrier, was sunk off the Panhandle of Florida with the intention of creating an artificial reef in 2006. The ship was overhauled to ensure no toxins (for example paints or oils) would seep from it into the marine environment. Since its sinking, the *Oriskany* has become a popular diving location to see reef fish.

KEY TERMS

Anchorage: [boats] the portion of a harbour or estuary used for ships to anchor; [organisms] location on a substrate where a sessile organism attaches and lives

Artificial reef: an artificial underwater structure built to mimic the characteristics of a natural reef

Figure 5.8. Commercially available artificial reef balls.

Artificial reefs provide a physical structure for coral, sponges and algae to colonise. Once these sessile animals have become attached and begun to colonise, many different species of fish are attracted to the area. After several years, it should be impossible to tell that the reef was once an artificial construct, it will so closely resemble a genuine coral reef. At the Cancun Underwater Museum in Mexico, British artist Jason de Caires Taylor has created an art installation with more than 400 sculptures of humans designed to become artificial reefs. Even as these artificial reef sculptures are colonised, they may retain some of their original identity.

Opdracht bij les 3.3

- Kiezen uit de case studies: ‘Rif destructie door mensen’ OF ‘Doornenkroon zeesterren’

Les 3.3 - Rif destructie door mensen

Terwijl de meeste rif erosie op natuurlijke wijze gebeurt zoals biologische erosie en fysieke factoren zoals stormen, vindt een deel plaats door menselijk handelen. Menselijk handelen kan verschillende vormen aannemen. Vissen, toerisme, en oogsten van koraal zijn waarschijnlijk de meest voorkomende vormen van de vernietiging van koraalriffen wereldwijd.

Vissen in de buurt van een koraalrif is economisch gezien logisch vanwege de hoge biodiversiteit van een gezond koraalrif. Maar dit kan een aantal problemen veroorzaken. Als de vissers niet voorzichtig zijn. Kunnen ze het anker van hun boot neerlaten op een deel van het koraalrif, of met de buitenboordmotor het ondiepe deel van het rif beschadigen. Dit geldt ook voor toeristenboten en cruise schepen. Een enkel cruiseschip heeft bijvoorbeeld 3,150 vierkante kilometer rif beschadigd in Fiji in 2006.

Daarbij zijn vismethoden zoals dynamiet- en cyanide vissen ook gevaarlijk voor koraalriffen. Deze methoden worden gebruikt om vissen te verdoven zodat ze makkelijk te vangen zijn aan het oppervlak van het water met visnetten. De ontploffing van het dynamiet kan delen van het rif beschadigen, waarbij permanente schade wordt veroorzaakt. Cyanide visserij is vooral bedoeld om grotere vissen te verdoven om ze makkelijk te vangen, maar doodt ook kleine organismen zoals koralen. Overbevissing van de grote roofvissen op het rif heeft ook geleid tot een afname in visgrootte op de meeste riffen en zelf tot de verandering van ecosystemen op sommige riffen. Als de grote roofvissen of herbivore vissen worden verwijderd uit het koraalrif ecosysteem, zijn er geen organismen die algen en koraal-eters zoals de crown-of-thorn zeester tegenhouden om het rif over te nemen.

Het oogsten van koraal is een van de menselijke invloeden die niet bijkomstig is. Veel onopgeleide toeristen breken stukken koraal af om mee naar huis te nemen als souvenir, maar schade wordt ook vaak aangericht door lokale bedrijven. Zwart koraal kan worden gepolijst en verkocht als sierraden in veel delen van de wereld. Andere stukken koraal worden gedroogd en verkocht aan mensen als decoratie voor in hun huizen. Op grote schaal veroorzaakt dit oogsten van koraal schade die lange tijd nodig heeft om te herstellen.

1. Wat is de schade die het cruise schip heeft veroorzaakt in ecologische termen? Gebruik hierbij je kennis van de gemiddelde groei van een koraalrif.

2. Geef een mogelijke reden waarom overbevissing kan leiden tot erosie van een koraalrif.

3. Welk type koraal denk jij dat het meeste geoogst wordt, hermatypisch of ahermatypisch? Leg je antwoord uit.

Les 3.3 -Doornenkroon zeesterren

De doornenkroon zeester is een giftig roofdier dat op koraalriffen in de Indische en Grote Oceaan voorkomt. Dit roofdier is een belangrijk deel van het voedselweb op deze riffen. Op gezonde riffen voedt het zich met de snelst groeiende koralen. Het lijkt erop dat elke koraal predatie negatief is, maar door zich te voeden met deze snel groeiende koralen, zorgt de doornenkroon zeester ervoor dat de langzamer groeiende koralen zich ook kunnen ontwikkelen tot grote kolonies. Dit verhoogt de biodiversiteit op het rif. De doornenkroon zeester heeft een slechte reputatie als de vernietiger van het rif vanwege een aantal plagen in de laatste 50 jaar. Deze plagen kunnen meer dan 10 jaar duren terwijl de doornenkroon zeesterren zich over het rif naar het zuiden verspreiden.

Er is veel onderzoek gedaan naar de oorzaak van deze plagen. Grote doornenkroon zeester vrouwtjes kunnen wel 65 miljoen eieren produceren tijdens het broedseizoen, maar dit is niet abnormaal voor ongewervelden. Ten eerste moet er een toename zijn van bepaalde beperkende voedingsstoffen zoals stikstof en fosfor in het ecosysteem. Dit gebeurt wanneer er kunstmest met de run-off de zee in wordt gespoeld. Als deze voedingsstoffen in hoge concentratie aanwezig zijn, ontstaan er fytoplankton bloeien die als voedsel dienen voor doornenkroon zeesterlarven. Hierdoor overleven er meer larven dit stadium en ondergaan de metamorfose tot volwassen zeester.

In beide stadia hebben doornenkroon zeesterren nog roofdieren die op ze jagen. Dus de tweede factor is een afname in deze roofdieren. Koralen zelf kunnen de larven eten. Volwassen dieren worden gegeten door zeeslakken, zeebaars, en blaasvis. Wanneer deze dieren overbevist raken, kan het koraalrif overbevolkt raken met zeesterren.

Op het Groot Barrièrerif komen de plagen van de doornenkroon zeesterren cyclisch voor, ongeveer elke 15-17 jaar. De doornenkroon zeesterren zijn verantwoordelijk voor tot 36% van de schade aan het koraal.

1. Wat zijn de oorzaken van de doornenkroon zeester plagen?

2. Hoe kan het verlies van koraal door rif erosie na een cycloon leiden tot een uitbraak van een doornenkroon zeester plaag?

3. Leg uit hoe slechte vismethoden en afvalwater management kunnen leiden tot een uitbraak van een doornenkroon zeester plaag?

4. Leg uit wanneer en hoe doornenkroon zeesterren een positief effect kunnen hebben op het koraalrif.